**Section 8.1 What is an earthquake?**

**Key Concepts**

* [What is a fault?](javascript:openCrossRef('../ch8/ch8_s1_1.html%23lnk219.2'))
* [What is the cause of earthquakes?](javascript:openCrossRef('../ch8/ch8_s1_2.html%23lnk221.1'))

**Vocabulary**

* [elastic rebound hypothesis](javascript:openCrossRef('../ch8/ch8_s1_2.html%23lnk220.1'))
* [aftershock](javascript:openCrossRef('../ch8/ch8_s1_2.html%23lnk221.2'))
* [foreshock](javascript:openCrossRef('../ch8/ch8_s1_2.html%23lnk221.2'))
* [earthquake](javascript:openCrossRef('../ch8/ch8_s1_1.html%23lnk218.3'))
* [focus](javascript:openCrossRef('../ch8/ch8_s1_1.html%23lnk218.4'))
* [epicenter](javascript:openCrossRef('../ch8/ch8_s1_1.html%23lnk219.1'))
* [fault](javascript:openCrossRef('../ch8/ch8_s1_2.html%23lnk219.3'))

Each year, more than 30,000 earthquakes occur worldwide that are strong enough to be felt. Fortunately, most of these earthquakes are minor tremors and do very little damage. Generally, only about 75 major earthquakes take place each year. Most of these occur in remote regions. However, occasionally a large earthquake occurs near a city. Under these conditions, an earthquake is one of the most destructive natural forces on Earth, as shown in Figure 1.



**Figure 1** This damage occurred in San Francisco’s Marina District from the 1989 Loma Prieta earthquake.

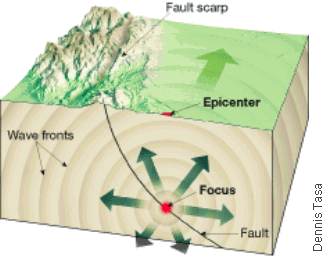
**Earthquakes**

An [**earthquake**](javascript:openGlossaryWnd('e_ga_06_earthquake')) is the vibration of Earth produced by the rapid release of energy. Earthquakes are often caused by slippage along a break in Earth’s crust.

**Focus and Epicenter**

The point within Earth where the earthquake starts is called the [**focus**](javascript:openGlossaryWnd('e_ga_06_focus')). The released energy radiates in all directions from the focus in the form of waves. These waves are similar to the waves produced when a stone is dropped into a calm pond. The impact of the stone sets water waves in motion. An earthquake is similar because it produces seismic waves that radiate throughout Earth.

The focus of an earthquake is the place within Earth where the earthquake originates. When you see a news report about an earthquake, the reporter always mentions the place on Earth’s surface where the earthquake has been located. The [**epicenter**](javascript:openGlossaryWnd('e_ga_06_epicenter')) is the location on the surface directly above the focus, as shown in Figure 2.



**Figure 2** The focus of each earthquake is the place within Earth where the earthquake originated. The foci (plural of focus) are located along faults. The surface location directly above the focus is called the epicenter. **Predicting** Where do you think the damage from an earthquake is usually greatest?

**Faults**

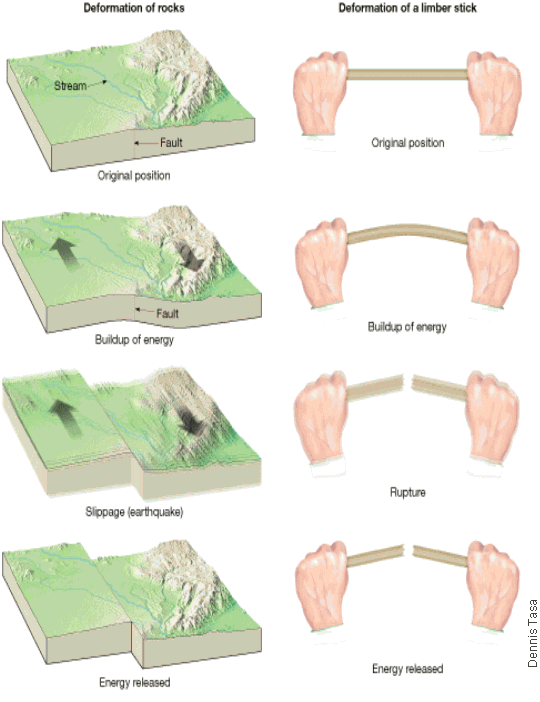
A lot of evidence shows that Earth is constantly changing. We know that Earth’s crust has been uplifted at times. We have found many ancient wave-cut features meters above the level of the highest tides. Offsets in fence lines, roads, and other structures indicate that horizontal movements of Earth’s crust are also common, as seen in Figure 3. Earthquakes are usually associated with large fractures in Earth’s crust and mantle called [**faults**](javascript:openGlossaryWnd('e_ga_06_fault')). **Faults are fractures in** **Earth where movement has occurred.**

**Figure 3** Slippage along a fault caused an offset in this orange grove east of Calexico, California. The white arrows show the direction of movement on either side of the fault.

**Cause of Earthquakes**

Before the great 1906 San Francisco earthquake, the actual causes and effects of earthquakes were not understood. The San Francisco earthquake caused horizontal shifts in Earth’s surface of several meters along the northern portion of the San Andreas Fault. The 1300-kilometer San Andreas fracture extends north and south through southern California. Studies following the 1906 quake found that during this single event, the land on the western side of the San Andreas Fault moved as much as 4.7 meters to the north compared to the land on the eastern side of the fault.

Based on these measurements and related studies, a hypothesis was developed to explain what had been observed. Figure 4 on page 220 illustrates this hypothesis. Part A shows an existing fault. In part B, forces within Earth slowly deform the crustal rocks on both sides of the fault, shown by the bent features of the rocks. These forces cause the rocks to bend and store elastic energy, just like a wooden stick does if it is bent. Elastic energy is the same kind of energy that is stored when you stretch a rubber band. Eventually, the resistance caused by internal friction that holds the rocks together is overcome. The rocks slip at the weakest point (the focus). The movement will exert forces farther along the fault, where additional slippage will occur until most of the built-up energy is released. This slippage allows the deformed rock to snap back in place. The vibrations we call an earthquake occur as the rock elastically returns to its original shape.

**Figure 4** As rock is stressed it bends, storing elastic energy. Once the rock is strained beyond its breaking point, it ruptures and releases the stored energy in the form of seismic waves. **Inferring** How do you think the temperature of rock would affect its ability to bend or break?

**Elastic Rebound Hypothesis**

The springing back of the rock into its original place is called elastic rebound. The rock behaves much like a stretched rubber band does when it is released. The explanation says that when rocks are deformed, they first bend and then break, releasing stored energy. This explanation for the release of energy stored in deformed rocks is called the [**elastic rebound hypothesis**](javascript:openGlossaryWnd('e_ga_06_elstrebndhyp')).

**Most earthquakes are produced by the rapid release of elastic energy stored in rock that has been subjected to great forces. When the strength of the rock is exceeded, it suddenly breaks, causing the vibrations of an earthquake.** Earthquakes most often happen along existing faults. They occur when the frictional forces on the fault surfaces are overcome.

**Aftershocks and Foreshocks**

The intense shaking of the 1906 San Francisco earthquake lasted about 40 seconds. Most of the movement along the fault occurred in this short time period. However, additional movements along this and nearby faults continued for several days. The movements that follow a major earthquake often produce smaller earthquakes called [**aftershocks**](javascript:openGlossaryWnd('e_ga_06_aftershock')). These aftershocks are usually much weaker than the main earthquake, but they can sometimes destroy structures weakened by the main quake. Small earthquakes called [**foreshocks**](javascript:openGlossaryWnd('e_ga_06_foreshock')) often come before a major earthquake. These foreshocks can happen days or even years before the major quake.

The San Andreas Fault is the most studied fault system in the world. Studies have shown that displacement has occurred along segments that are 100 to 200 kilometers long. Each fault segment behaves a bit differently than the other segments. Some parts of the San Andreas show a slow, gradual movement known as fault creep. This movement happens fairly smoothly. Other segments regularly slip and produce small earthquakes. However, some segments stay locked and store elastic energy for hundreds of years before they break and cause great earthquakes.

**SECTION 8.1 Assessment** *Complete on lined paper and in complete sentences*

**Reviewing Concepts**

(1)What is a fault?

(2)Describe the cause of earthquakes.

(3) What is an earthquake?

(4)What is the source of an earthquake called?

(5)What are foreshocks and aftershocks?

**Critical Thinking**

(6) **Connecting Concepts** How are faults, foci, and epicenters related?

(7) **Inferring** What is meant by elastic rebound?

(8) **Making Judgments** Why do most earthquakes cause little damage and loss of life?

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